Alpha Magnetic Spectrometer – 02
Phase II Ground Safety Review

Ground Operations

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Outline

- Operations Timeline
- Operations Flow Diagram
- Ground Operations
  - Off-Line, Non-Payload Tests
  - Off-Line Payload Processing: SSPF
  - On-Line Payload Processing:
    - SSPF
    - Canister Ops
    - Pad / PCR Ops
    - Abort
- Launch Commit and Go / No Go Criteria

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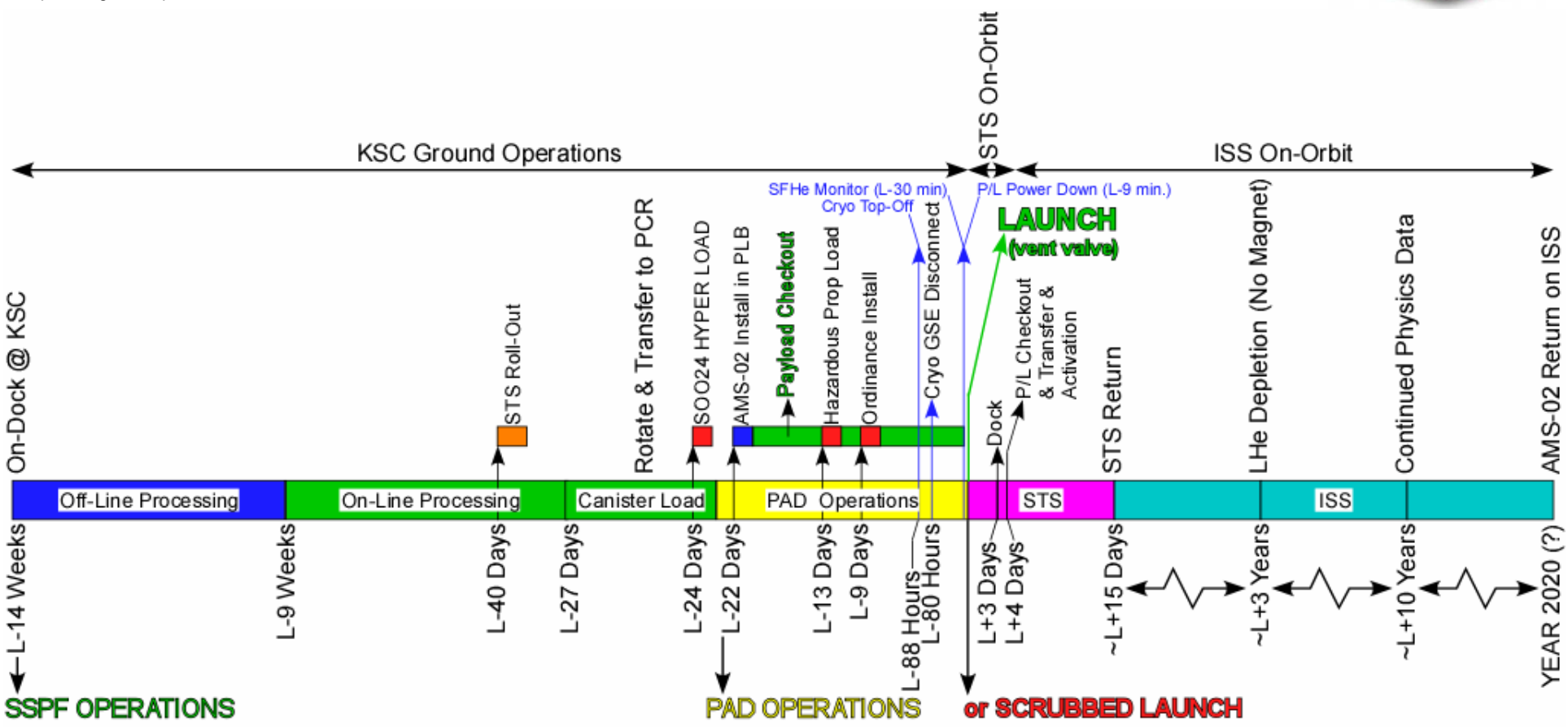
Ground Operations - Timeline



Parallel, Off-Line, Non-Payload Tests:

- POPIT2
  - MLP Launch Commit Criteria Tests
  - Flight Specific MLP Data Transmission Tests
- OPF Orbiter Sill-Side Test

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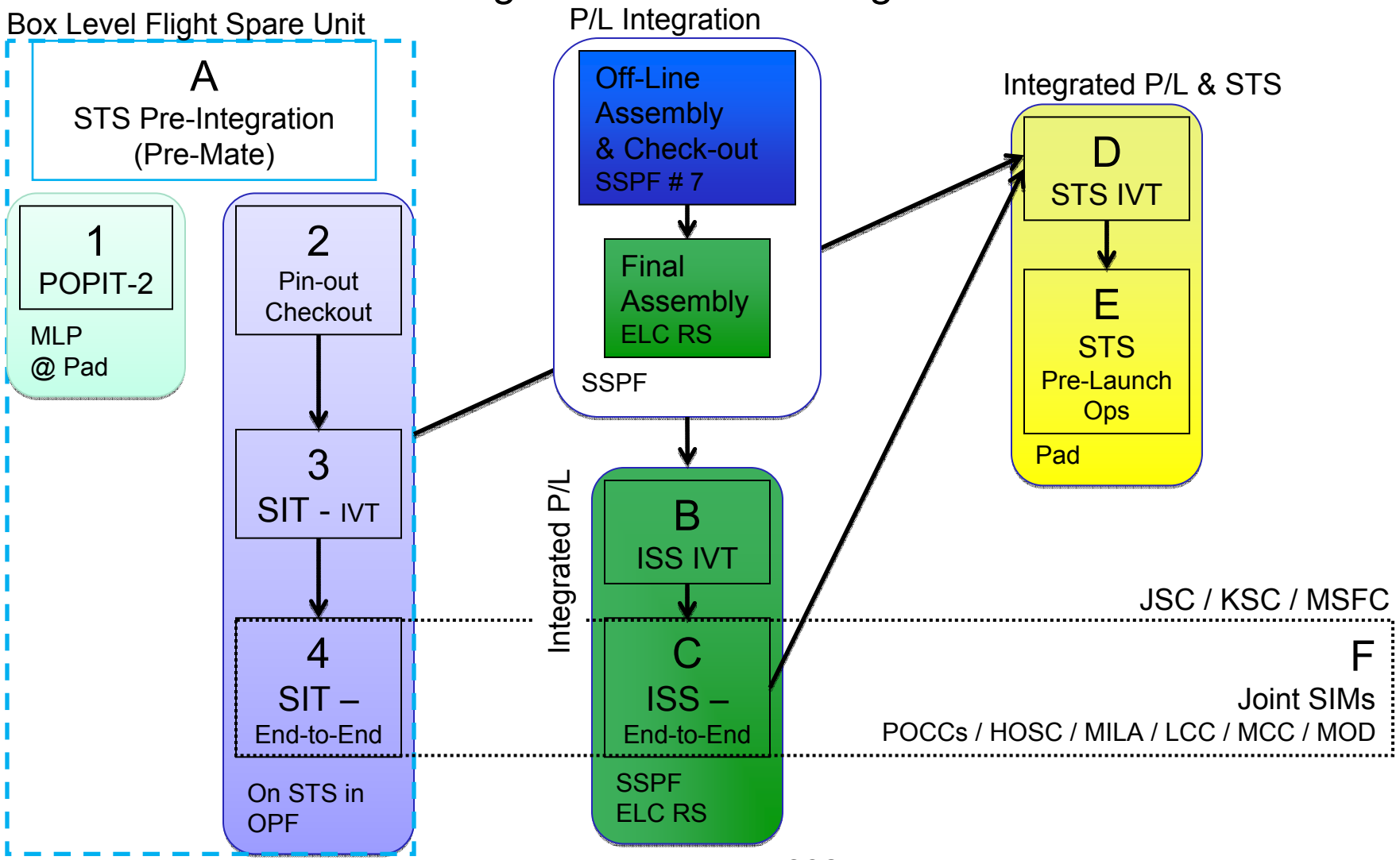
Processing and Test Flow Diagram



Parallel Off-Line Non-Payload Tests

A. STS Pre-Mate Verifications

- To be worked in parallel with payload processing
- Utilize flight spare Class I stand-alone components:
  - Pad Operations Preliminary Interface Test (POPIT) 2
  - STS Interface Test (SIT) *{OPF Orbiter Sill-Side Test}*

Blue Dashed Line on Flow Diagram

Parallel Off-Line Non-Payload Tests

1. POPIT-2: Empty, flight specific MLP at the pad
   a. Repeat POPIT for 1553 & RS-422 using J-Crate Flight Spare Unit
   b. Perform LCC and KSC POCC Verifications (1553 & RS-422)
      i. P/L Critical Health Data → Launch Control Center P/L Console
      ii. P/L ↔ KSC POCC
   c. T0 P/L Power Services: 120VDC and 110 VAC
      i. Verify pin-out from MLP Room 10 A to T0
      ii. Power out and abort simulations verifying monitor and control of power services

Parallel Off-Line Non-Payload Tests

2. Pin-out verifications prior to STS Interface Test (SIT)
3. STS Interface Test (SIT) – Interface Verification Testing (IVT)
    a. J-Crate (P/L Computer) ↔ DDRS-02 (P/L AFD Data Recorder)
    b. J-Crate FEU → Ku-Band
    c. J-Crate FEU ↔ S-Band
    d. J-Crate FEU ↔ T0
    e. DDRS-02 (playback) → Ku-Band
4. STS Interface Test (SIT) – End-to-End; all the way to JSC POCC
    - Can be part of joint STS and AMS-02 Simulation (F)

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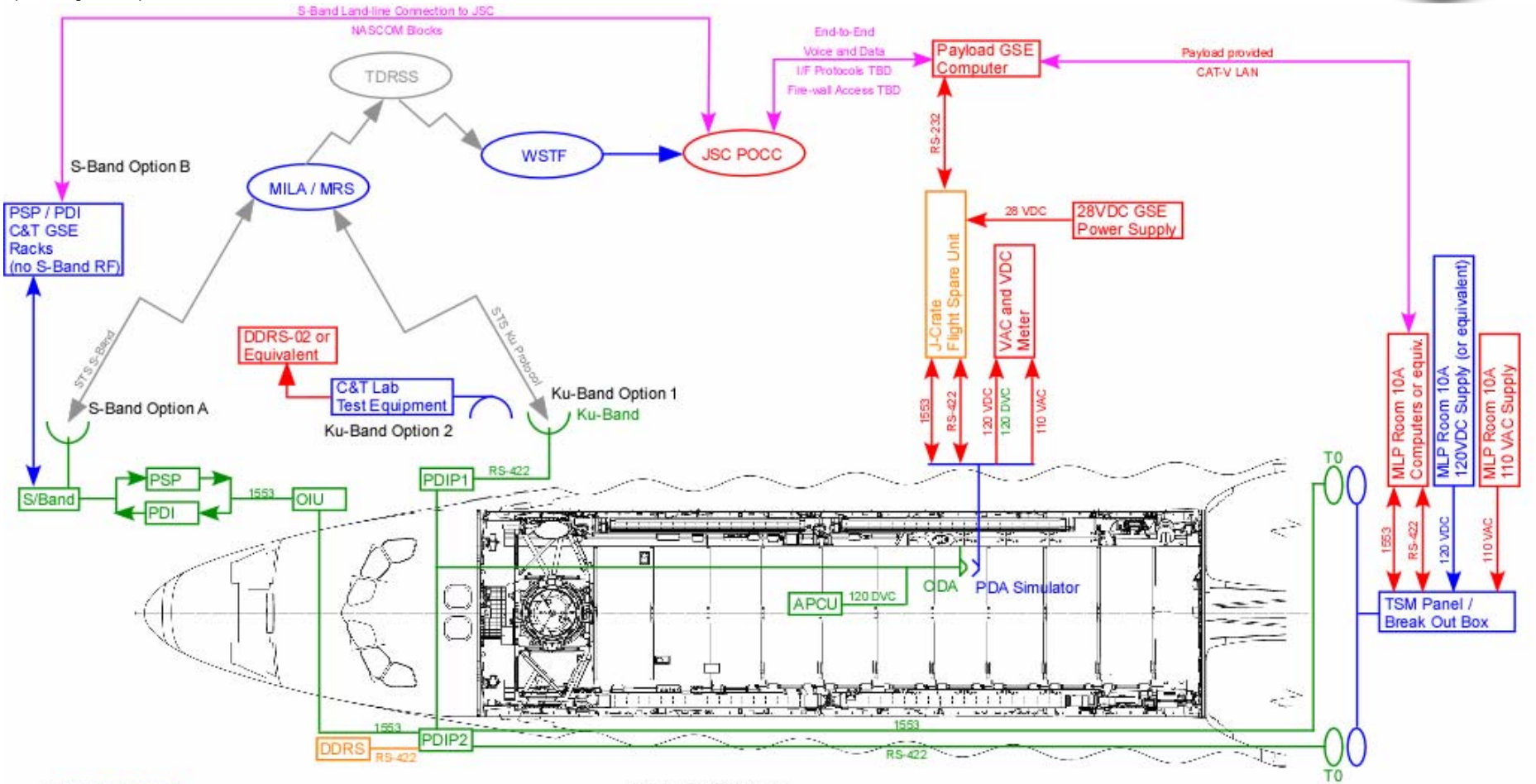
STS Interface Test (SIT) Schematic



STS FLIGHT

STS GSE or Ground Systems

AMS-02 P/L FLIGHT

AMS-02 GSE or Ground Systems

RF Link

Internet / LAN

Note:
MILA Functionality, and associated KSC support, is a KSC STS programmatic issue, without which this portion of the test is TBD.

Ku-Band Option 1:
End-to-end RF / STS Ku to MILA to TDRSS to WSTF to JSC POCC, complete test of Ch. 2 format & transmission

Ku-Band Option 2:
Hardwire "short-cut" / STS Ku cap to C&T lab patch to split off Ku Ch.2 to DDRS-02 as well as bit sync.

S-Band Option A:
End-to-end RF / STS S-Band to MILA to TDRSS to WSTF to JSC POCC, complete test of format & transmission

S-Band Option B:
Hardwire "short-cut" / STS S-band to C&T lab PSP/PDI patch to route NASCOM blocks to JSC / LRDL / FEP.

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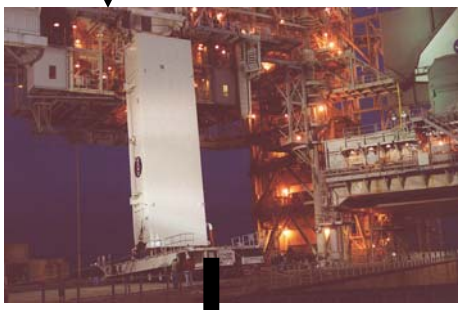


KSC Flow: Off-Line

- Arrive at Space Station Processing Facility (SSPF)
- Re-Assemble Lower USS to Upper USS
- Set-up and test CGSE and EGSE, including facility interfaces
- Top-off SFHe
- Power up/checkout Avionics and charge Cryomagnet (via Test Connector Panel / Interface Panel A)
- Integrate remainder of AMS-02 hardware
  - Handrails
  - PAS
  - Remove Test Connector Panel
  - Re-Route Integration Cables and Terminate at EVA Connector Panel

KSC Flow: On-Line

- Remove AMS-02 from Payload Support Structure (PSS)
- Transfer AMS-02 to ELC Rotation Stand
- Install Grapple Fixtures (PSS exclusion)

KSC Flow: On-Line (continued)

B. ISS Interface Verification Test (SSPF ELC)

With Integrated Payload – KSC PRCU Check-out

- Functional Interface Test (FIT)
  - EBCS Camera Alignment
  - PAS / UMA Functional Fits
  - ISS Data (PRCU) and Power (PEPSE) Testing (via UMA)
    a. 1553 & HRDL to PRCU
    b. To HOSC
    c. To JSC POCC
  - Can be used to support joint SIMs (F)
- Power up / checkout avionics, no Magnet Charge

Return P/L to PSS and monitor until Canister Operations

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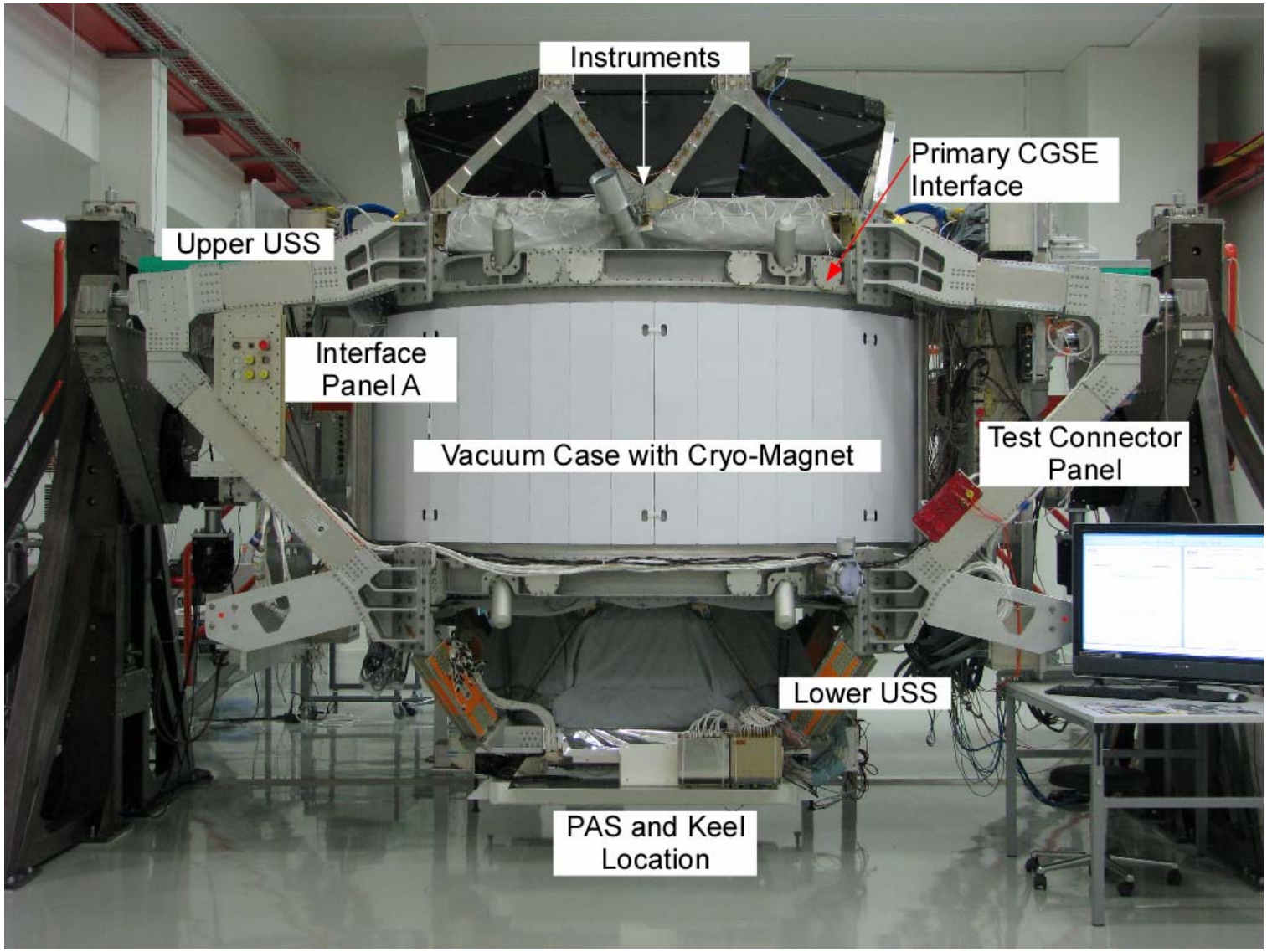
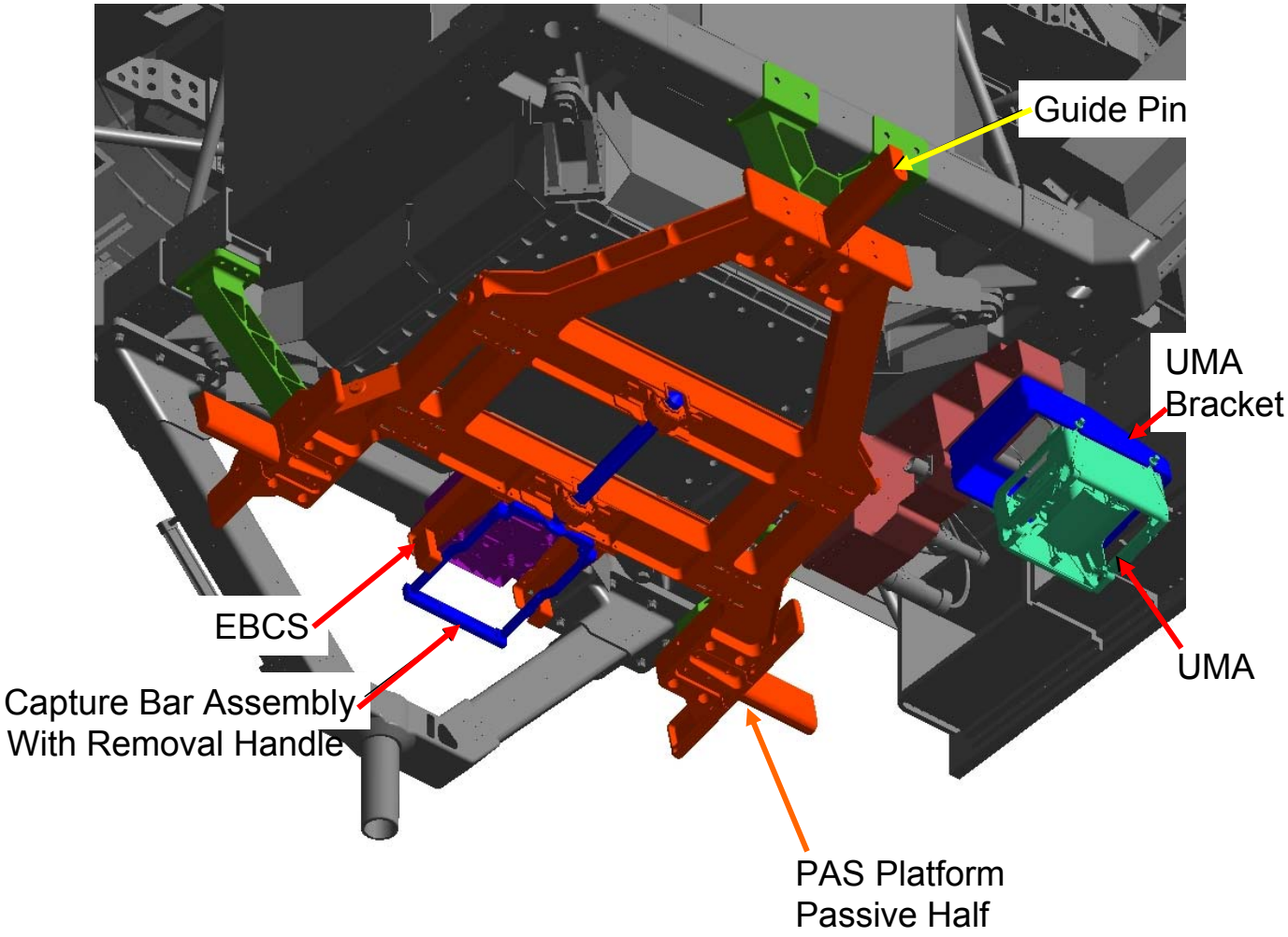
Payload Component Locations

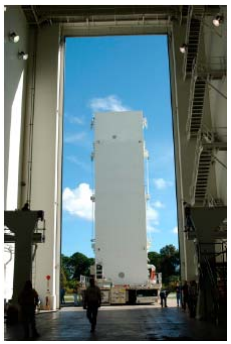


Alpha Magnetic Spectrometer – 02
PAS, EBCS and UMA Locations



KSC Flow: On-Line (continued)

- Load into canister and transport to Canister Rotation Facility (CRF) – will require On-Board Pump (SFHe), possibly data connections
- Rotate canister in CRF
- Transport to Pad for Vertical Installation in Payload Change-out Room (PCR) using Payload Ground Handling Mechanism (PGHM)
- In parallel with canister operations, the P/L CGSE (subset) will be transferred from the SSPF to the pad

KSC Flow: On-Line (continued)

- Mate STS ROEU ODA/PDA Interface
- Install P/L GSE vent lines
- STS Interface Verification Test (IVT)
- End-to-End P/L Tests in STS
- Remainder P/L CGSE connection
- Continued GSE payload servicing, including SFHe top-off
- Payload close-out and GSE disconnected
- Continued payload monitoring until 120 VDC power-off

KSC Flow: On-Line (continued)

D. STS Mated Interface Verification Test / Functional Test:

With Integrated Payload in Shuttle PLB at Pad: Check-out

1. 1553 & RS422 command and monitor
2. Fully functional check-out except magnet charge and thermal control systems (not possible in 1g)
3. Including DDRS-02 on AFD

KSC Flow: On-Line (continued)

E. PAD OPERATIONS

Installation at L-22 days through L-9 minutes:

- L-88 hours:
  - Complete Top-off SFHe
  - Disconnect and remove TRD Gas Bottle
  - Close SFHe Tank Vent Valve
  - Cap P/L Vent Lines
  - Activate/checkout AMS-02 avionics subsystems and thermally condition payload
    - Approximately 1000 ~ 1500 W for J-Crate, Cryo-valves, Cryo-coolers, CAB critical functions, and SFHe On-Board Pump
    - Maximum of 2 kW (peak) for calibration and contingency based upon thermal load in maximum flow / minimum temperature purged PLB
    - Thermal monitoring & considerations may drive subsystem power cycling
  - Payload GSE interface disconnect

KSC Flow: On-Line (continued)

E. PAD OPERATIONS (continued)

- L-80 hours PLB door close
- At L-30 minutes:
  - Deactivate On-Board Pump (110 VAC)
  - Power down Cryo-coolers
  - Power down all equipment with the exception of J-Crate and necessary CAB functions to monitor of cryogenics system health (limited to 120W)
- LCC: Monitor health status of cryogenic systems until L-9 min: GO / NO GO Call from AMS-02 based on Cryogenic System Health
- At L-9 minutes: 120 VDC Payload Power-Down
  - STS AFD Standard Switch Panel (SSP) provided 28 VDC is on

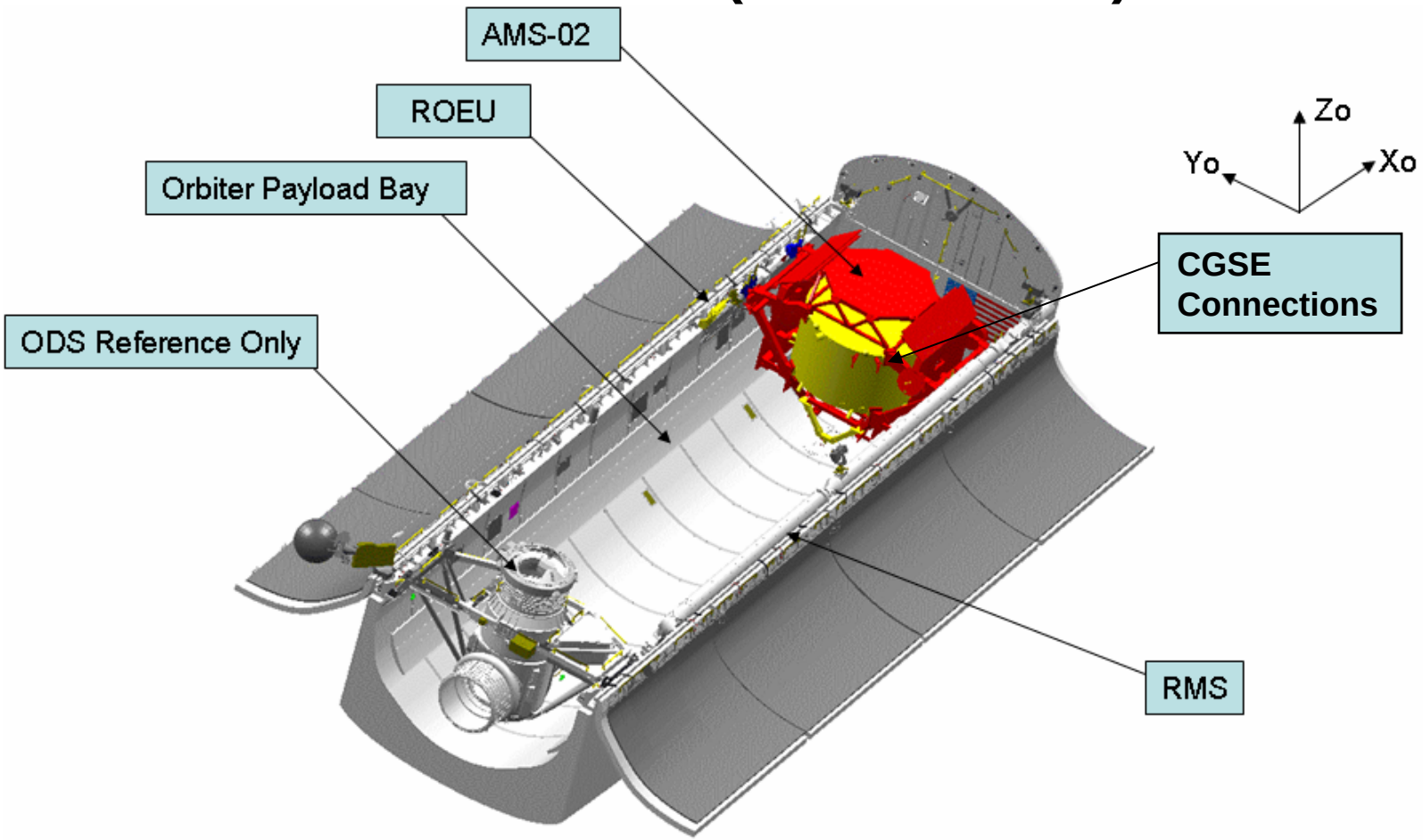
KSC Flow: On-Line (continued)

E. PAD OPERATIONS

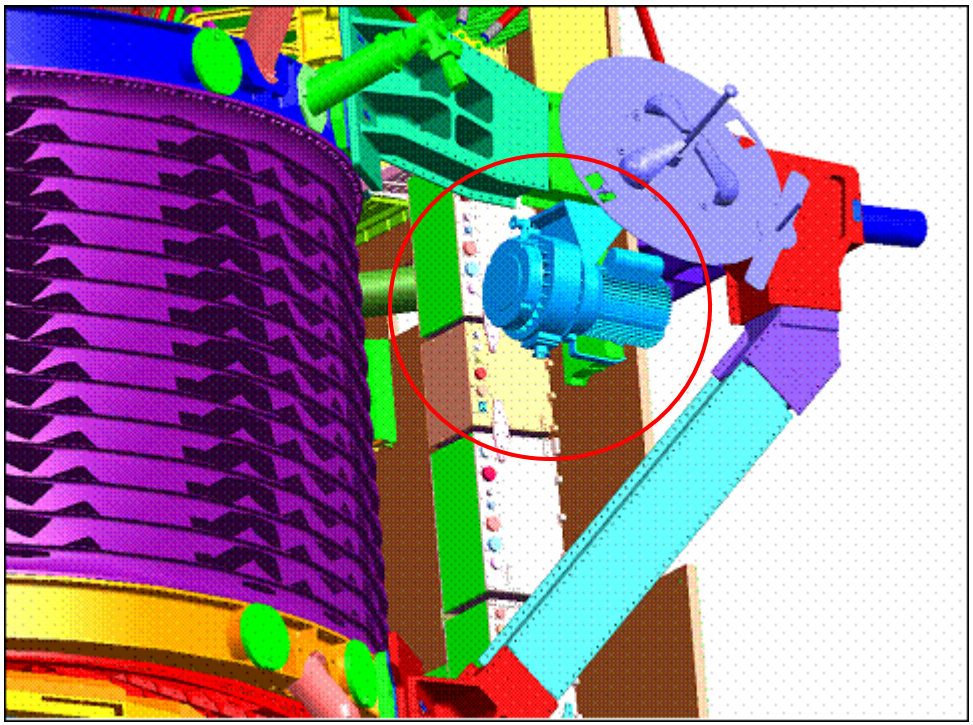
⇨ **No magnet charging possible on STS:**

- STS Flight APCU power supplied to prime PDS side “B” has no connectivity to the CAB
- Magnet charging on Pad via T0 is operationally controlled
  - Monitored with positive feed-back until L-9 minutes
  - Multiple non-stored commands required to initiate

AMS-02 in PLB (CGSE access)

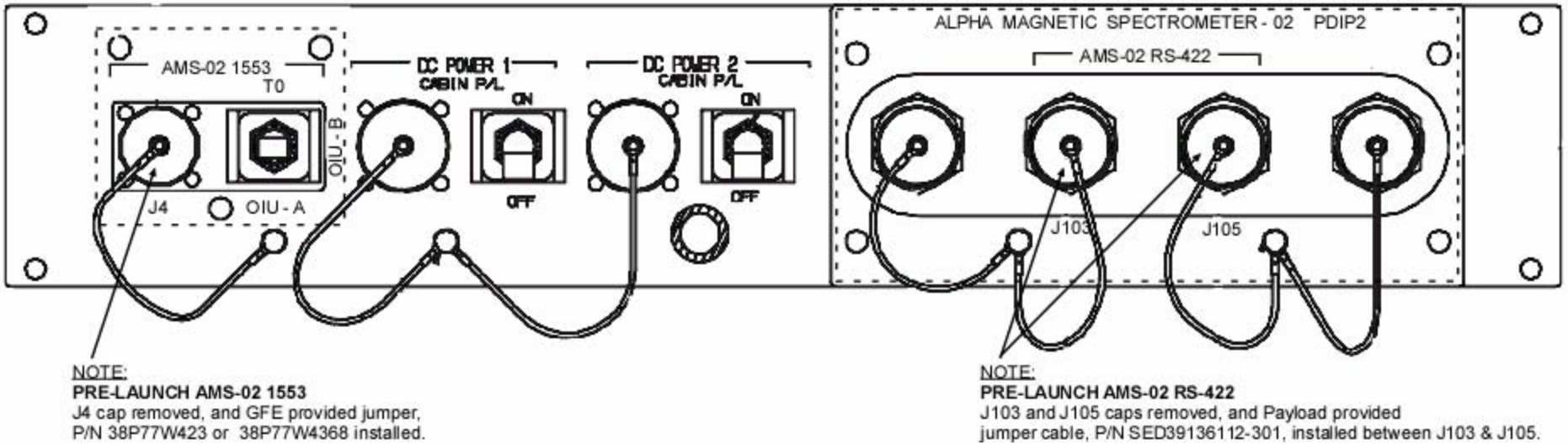


SFHe On-Board Pump



- Pre-Launch only
- T0 110 VAC interface and ground safety being worked with STS Program and KSC
- Rotating parts analysis complete

Pre-Launch Configuration
Payload Data Interface Panel 2 (PDIP#2)



- Low rate data (1553) is routed through T0 umbilical to MLP GSE computers from Shuttle PDIP2 with the “AMS-02 1553” switch in the “T0” position, and program provided jumper installed on PDIP2 front panel “J4” connector
- High rate data (RS422) is routed through T0 umbilical to MLP GSE computers from Shuttle PDIP2 via payload provided cable installed between PDIP2 front panel “J103” and “J105” connectors.

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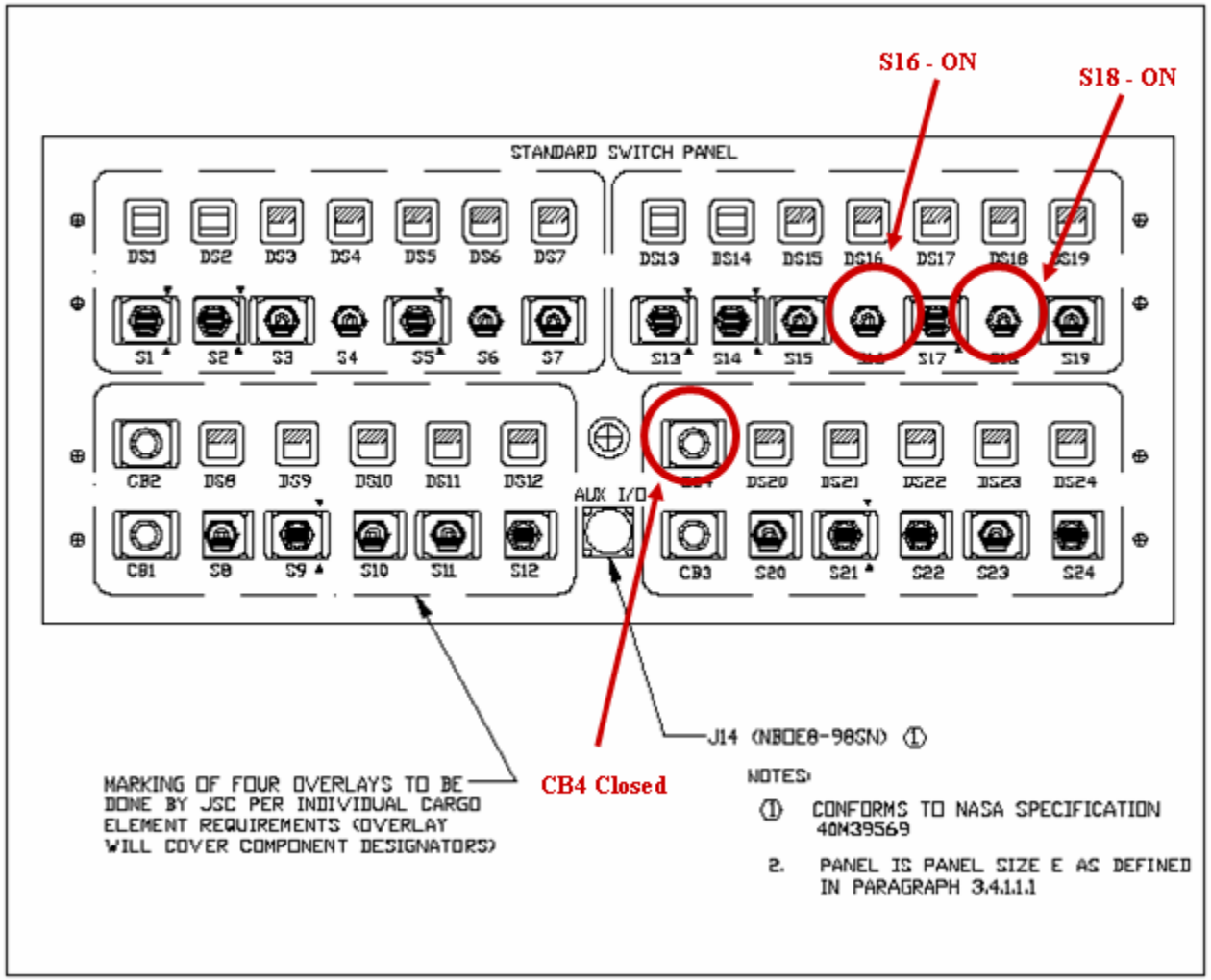
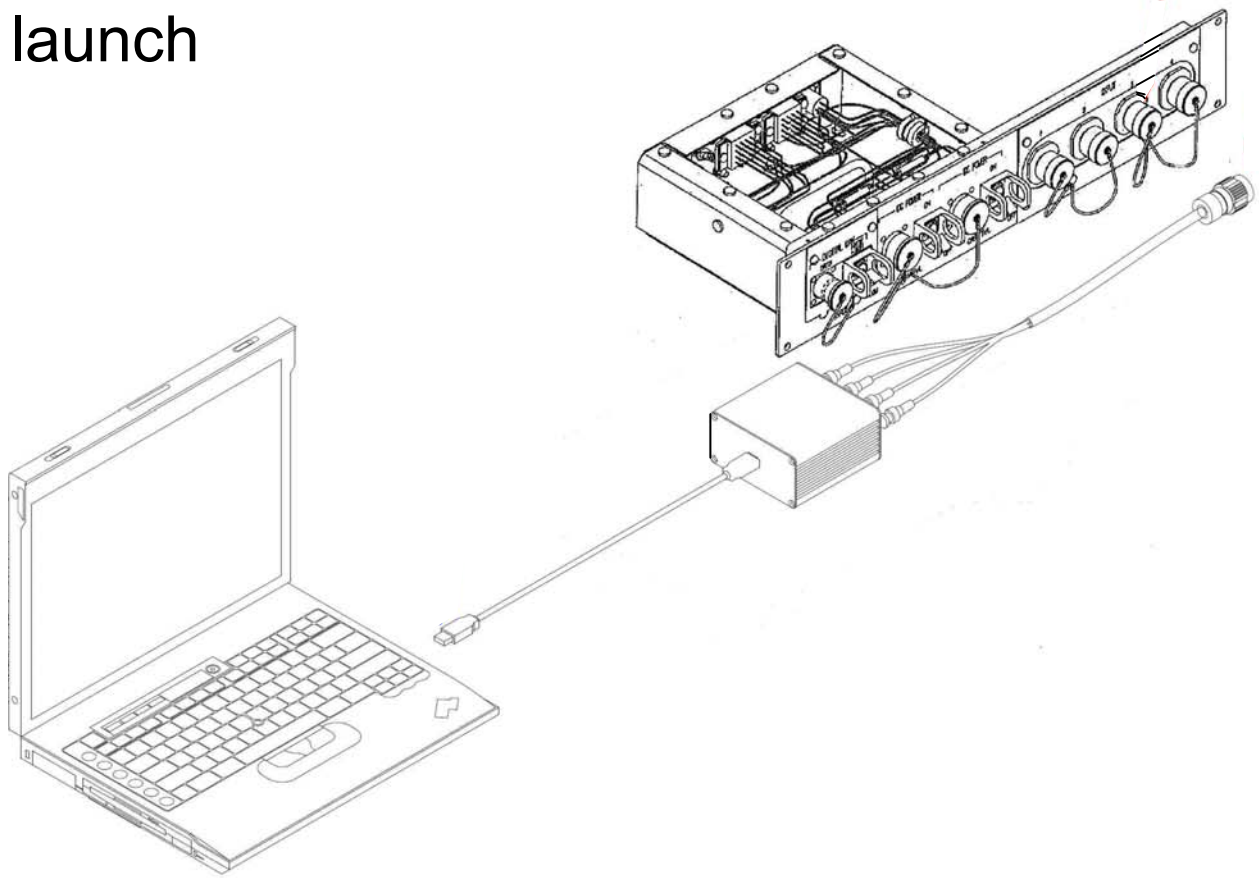
Pre-Launch Standard Switch Panel Configuration



Digital Data Recorder System-02 (DDRS-02)

- Will be used on Aft Flight Deck in STS end-to-end tests
- Stowed for launch

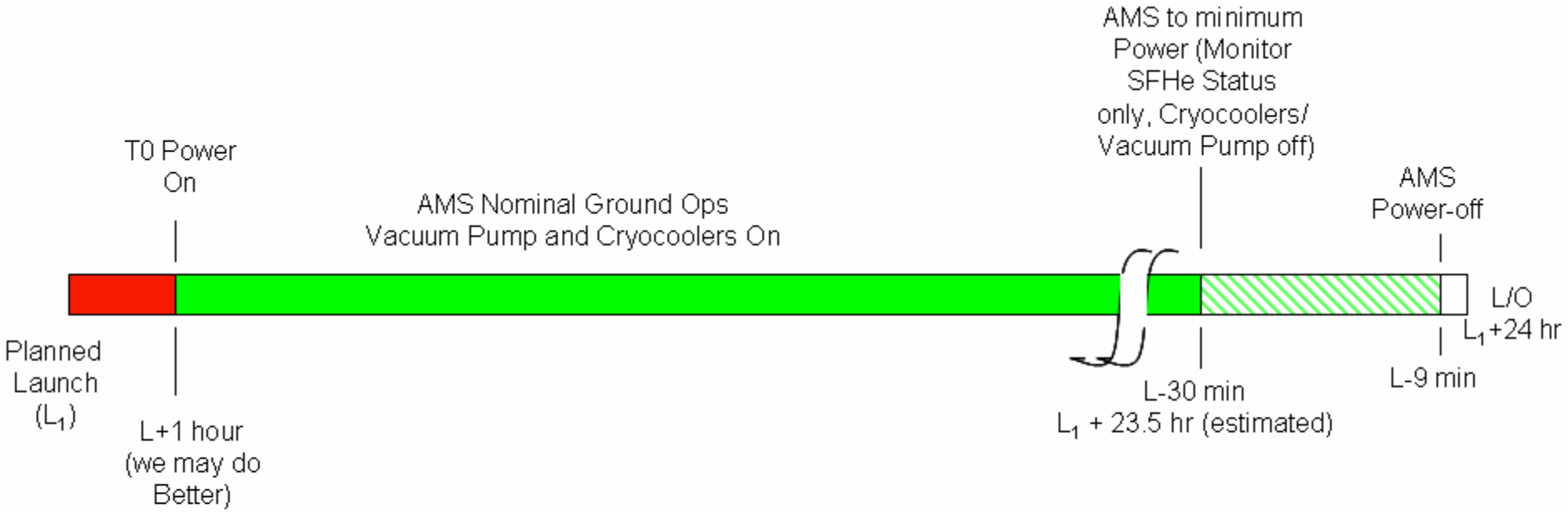


Mission Abort

- In the event of a flight abort, P/L Baroswitch Electronics automatically closes vent valve when PLB pressure exceeds 15 – 20 millibars (mission success only)
- If possible, upon landing, services should be applied via the T0 Umbilical to perform the following:
  - Allow internal Electronics to Monitor SFHe tank pressure
  - Operate vent valve and on-board pump
  - Not a safety concern, but rather a refurbishment concern (don't want to rupture burst disks)
  - Initial projection from KSC for nominal landing indicates ~ 10 hrs.

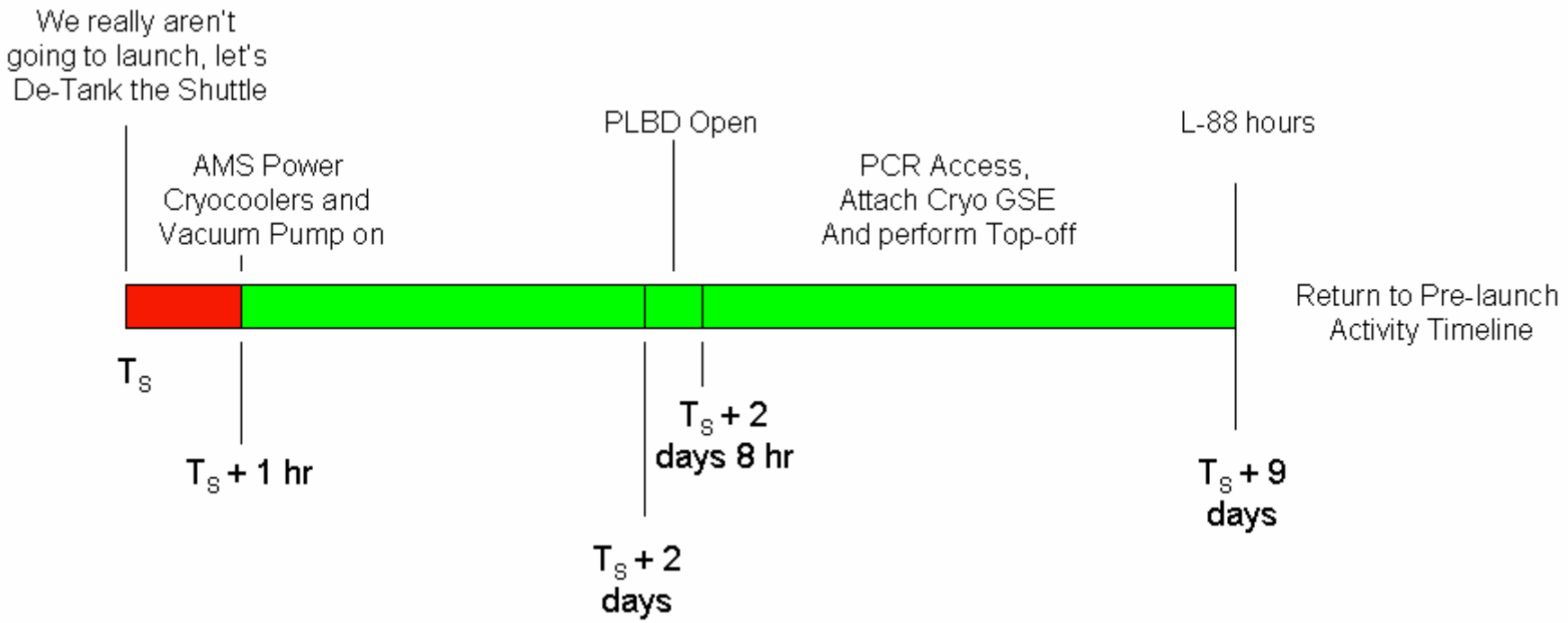
⇨ **Endurance & Mission Success for turn-around**

Launch Scrub Turnaround Scenario



This scenario can be repeated up to 96 hours from first launch attempt (L_1)
Typically, a maximum of four launch attempts are made prior to re-servicing, so one day may be maintained
At AMS Nominal Ops without attempting a launch.

Launch Scrub Recycle Turnaround Scenario



Hurricane Plan

Power down – safe without services.

- Including roll-back to VAB if necessary
- No safety requirements driving KSC reconnection – endurance and mission success only

Mission assurance concerns at 96 hours.

Safety Launch Commit Criteria – 1 of 2

Loss of vacuum case seal immediately prior to launch possibly results in over-pressurization of the SFHe Tank during ascent, venting into and over-pressurizing the PLB and damaging the Aft Bulkhead

- Worst case leak in VC requires 23 minutes to generate sufficient He to burst disks, releasing gas into PLB
- For PLB over-pressurization to present a hazard to the Orbiter, the over-pressurization must occur between L+30 seconds and L+1 minute
- Monitor Cryo-system health / status until L-9 minutes, ensuring insufficient time to release gas, thus preventing launch with hazard potential
  - Compared to trend data established over the lifetime of the experiment to indicate occurrence, and make the GO / NO GO Call
  - Minimum of three measurements of temperature and pressure within the SFHe Tank will provide this data on redundant paths

Safety Launch Commit Criteria – 2 of 2

Ensure MLP GSE Power Supplies are powered off, ensuring dead-faced T0 Connections

Payload Go / No Go Criteria

- The only payload mission success **Go / No Go Criteria** that has been defined relates to the operability of ISS Bus A prior to PLB door closure.
  - Because this bus is required for magnet charging, verification that this bus is operational must be made prior to launch.
  - EVA Connector Panel connections can be swapped to rectify lack of ISS Bus A prior to launch.

Backup Slides

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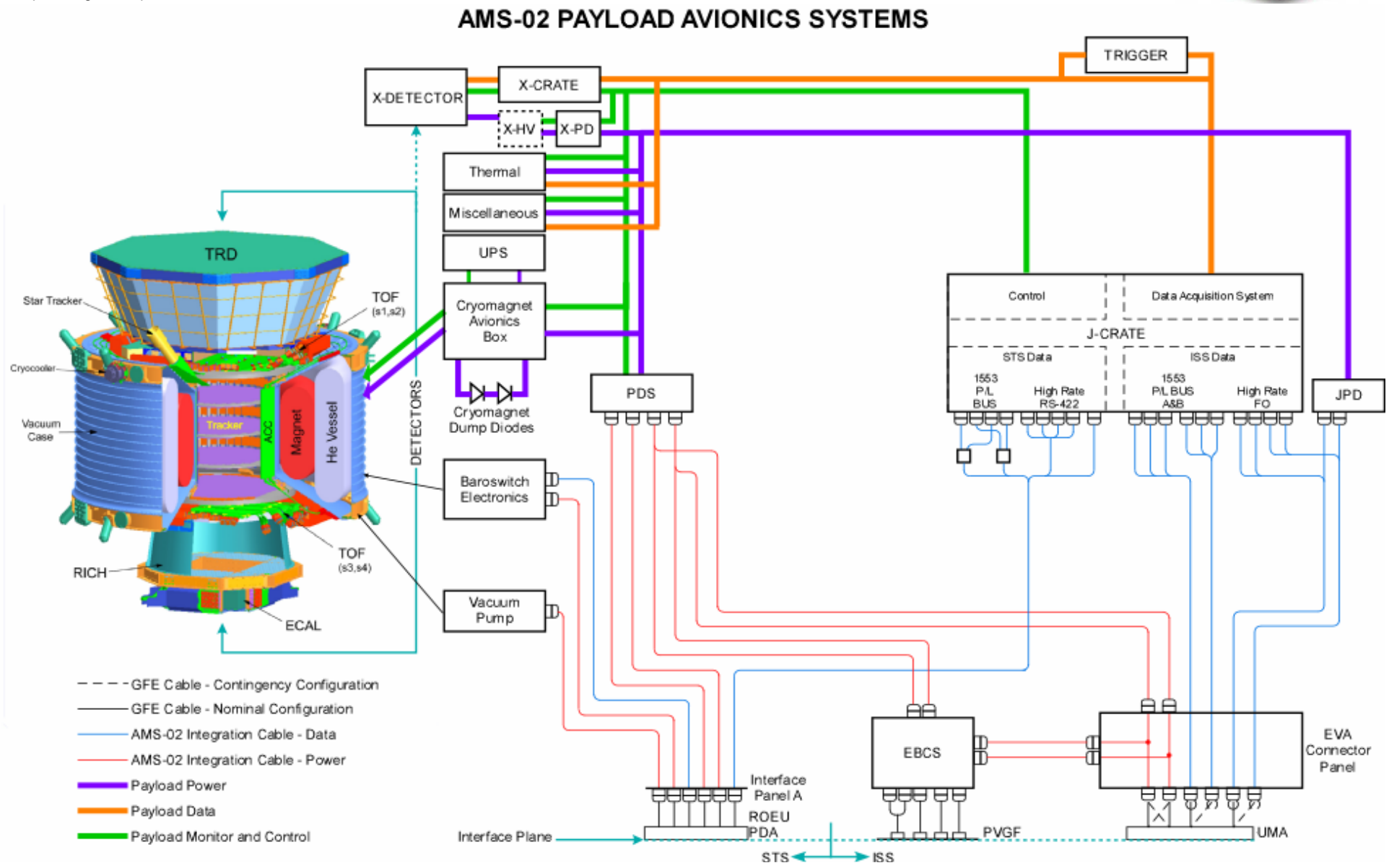

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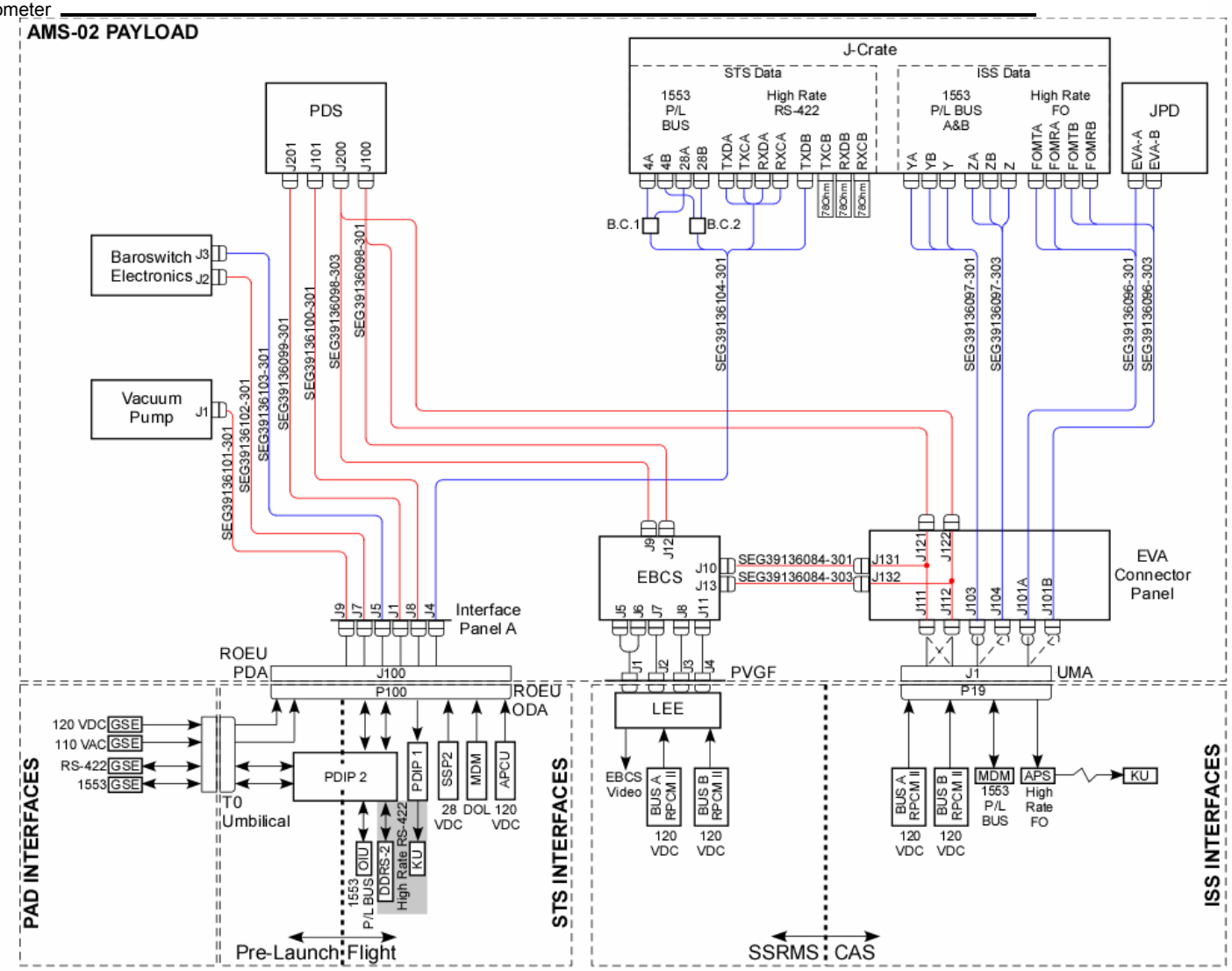
Payload Avionics Universal Interface Diagram



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Payload Interface Diagram – STS Pre-Launch